

# Incidence of Femoral Fractures in Postmenopausal Women

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**F**EMORAL FRACTURES sustained by older women are a major public health problem. Despite this, there has been little study of either their etiology or prevention. For example, the extent to which the likelihood of falling varies with the environment and with the age, sex, and other characteristics of the injured is quantitatively unknown. Similarly, although there is much clinical and pathological evidence of the importance of altered injury thresholds associated with postmenopausal osteoporosis and other conditions, there is little exact information as to their contribution.

Although the prevention of falls per se is probably important, attention also must be directed toward the maintenance of sufficiently high injury thresholds so that the forces released in falling produce minimum structural damage.

With this latter consideration in mind, we have studied the incidence of femoral fractures in a population of older women before and after fluoridation of their community water supply.

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This work was undertaken because the ingestion of fluoride, at least in large quantities, has been reported to result in positive calcium balance in patients with bone disease and to produce increases in bone mineralization and bone accretion rates, all of which might be expected to be associated with increased resistance to injury. In addition, attention has been called to this possibility by statements in the press that the fluoridation of water supplies might result in reductions in fracture rates among the elderly.

## Research Design and Methods

The 1960 population of Elmira, N.Y., was 46,517, and of Chemung County including Elmira, 98,706. Elmira was chosen for study because of the high quality of its medical care, its geographic isolation, its population characteristics, and the date of fluoridation of its water supply. The research design provided for the comparison of femoral fracture rates for women 60 years or older during the 5 years before and the 5 years after fluoridation of the city's supply in January 1953. Before January 1953, the Elmira water supply contained 0.01 to 0.02 ppm of fluoride as compared with 1.0 ppm after fluoridation. No other water supply in the county was fluoridated before 1959.

The records of the two hospitals in Elmira, the only ones within the county, were the source of the case material. The case series consisted of all women residents of Elmira 60 years or older who were hospitalized with femoral fractures during 1948 through 1957. Age, date of injury, fracture site, concomitant bone pathol-

ogy, and circumstances of injury were obtained for all members of the case series. In addition, more limited information was obtained for all other persons hospitalized with femoral fractures during this 10-year period.

### Results

From 1948 through 1957, a total of 521 women and 262 men were hospitalized with femoral fractures. Eighty-one percent (420) of the women and 45 percent (118) of the men were 60 years or older. Only 9 percent of the women were under 40 years of age as compared with 40 percent of the men (table 1).

Sixty percent (251) of the women 60 years or older lived in Elmira and 85 percent (356) in Chemung County including Elmira. The residence distribution did not change during the 10-year period.

Femoral fracture rates for Elmira women 60 years or older (table 2) did not differ significantly before or after fluoridation of the Elmira water supply ( $P>0.5$ , partitioned  $\chi^2$ ).

Among women 60 years or older, the mean fracture rate in the county, excluding Elmira, was lower for the second 5-year period than the first, but there were few cases, and no trend was apparent over the 10-year period (fig. 1). The mean annual rate during 1948 through 1957 was higher for women 60 years or older who were

**Table 1. All hospital admissions for femoral fractures, by age and sex, Elmira, N.Y., 1948-57**

Age group (years)	Number of admissions	
	Women	Men
Total.....	521	262
0-39.....	47	106
40-59.....	54	38
60 or older.....	420	118

living in Elmira (5.6 per 1,000) than for those living in the remainder of the county (3.9 per 1,000).

Falls from ground level or a height of less than one story reportedly preceded injury in 55 percent of the Elmira women 60 years or older. Thirty-eight percent of the fractures were attributed to falls from an unspecified height, and the majority of these were recorded as "fell," "fell at home," "tripped," or similar incidents (table 3).

According to the records, 20 percent (49) of the Elmira women 60 years or older had concomitant bone pathology, 19 percent (22) of those hospitalized during the 5 years before fluoridation and 20 percent (27) of those hospitalized during the 5 years after fluoridation (table 4).

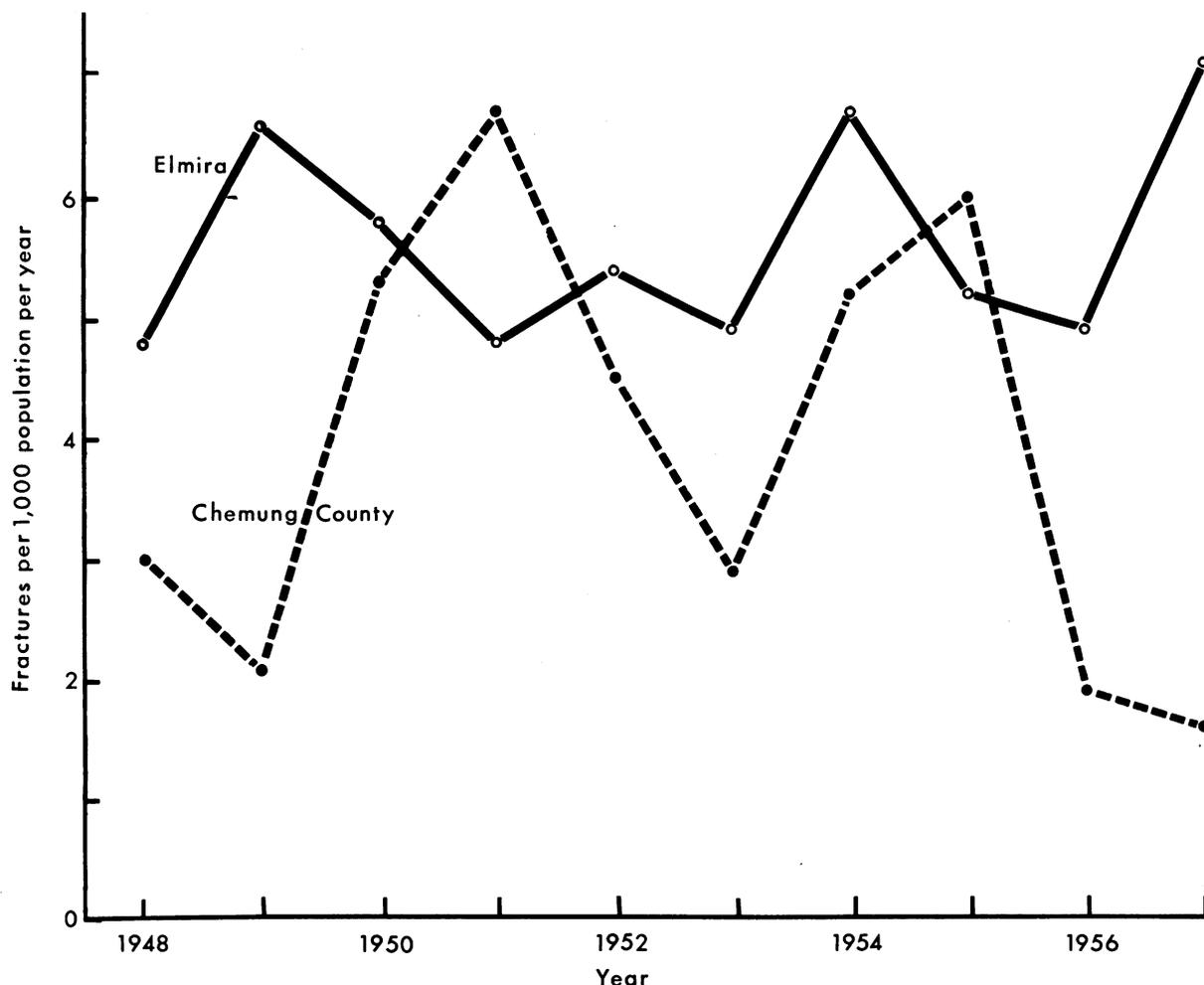
**Table 2. Age-specific femoral fracture rates for Elmira women 60 years or older, by year of admission to hospital, 1948-57**

Year	60-64 years		65-69 years		70-74 years		75-84 years		85 years or over		Total	
	Number <sup>1</sup> and pop-ulation <sup>2</sup>	Rate per 1,000	Number <sup>1</sup> and pop-ulation <sup>2</sup>	Rate per 1,000	Number <sup>1</sup> and pop-ulation <sup>2</sup>	Rate per 1,000	Number <sup>1</sup> and pop-ulation <sup>2</sup>	Rate per 1,000	Number <sup>1</sup> and pop-ulation <sup>2</sup>	Rate per 1,000	Number <sup>1</sup> and pop-ulation <sup>2</sup>	Rate per 1,000
1948-52	9 6,520	1.4	16 5,567	2.9	26 4,207	6.2	46 4,374	10.5	20 1,013	19.7	117 21,681	5.4
1948	1 1,282	.8	1 1,085	.9	11 811	13.6	6 822	7.3	1 189	5.3	20 4,189	4.8
1949	3 1,302	2.3	7 1,101	6.4	4 823	4.9	8 847	9.4	6 195	30.8	28 4,268	6.6
1950	1 1,316	.8	2 1,117	1.8	6 837	7.2	13 873	14.9	3 202	4.9	25 4,345	5.8
1951	0 1,312	-----	2 1,127	1.8	3 858	3.5	11 902	2.2	5 210	23.8	21 4,409	4.8
1952	4 1,308	3.1	4 1,137	3.5	2 878	2.3	8 930	8.6	5 217	23.0	23 4,470	5.4
1953-57	9 6,477	1.4	15 5,835	2.6	16 4,701	3.4	63 5,079	12.4	31 1,202	25.8	134 23,294	5.8
1953	0 1,304	-----	5 1,147	4.4	5 899	5.6	8 959	8.3	4 225	17.8	22 4,534	4.9
1954	2 1,300	1.5	4 1,157	3.5	3 920	3.3	17 987	17.2	5 233	21.5	31 4,597	6.7
1955	0 1,295	-----	3 1,167	2.6	3 940	3.2	14 1,016	13.8	4 240	16.7	24 4,658	5.2
1956	3 1,291	2.3	0 1,177	-----	4 961	4.2	10 1,044	9.6	6 248	24.2	23 4,721	4.9
1957	4 1,287	3.1	3 1,187	2.5	1 981	1.0	14 1,073	13.0	12 256	46.9	34 4,784	7.1

<sup>1</sup> Fracture cases.

<sup>2</sup> Estimated by linear interpolation between 1940, 1950, and 1960 U.S. censuses.

**Figure 1. Femoral fracture rates for women 60 years or older in Elmira and Chemung County excluding Elmira, 1948-57**



**Table 3. Reported incidents preceding femoral fractures in Elmira women 60 years or older, 1948-57**

Incident	Age group (years)						Total 1948-52	Total 1953-57
	60-64	65-69	70-74	75-84	85 or over	Total		
Total fracture cases.....	18	31	42	109	51	251	117	134
Falls at ground level (ice, rugs, curb).....	8	11	17	44	8	88	46	42
Falls on steps or at heights less than 1 story (bed, chairs).....	6	8	6	21	9	50	22	28
Falls from unspecified height (at home, other).....	3	9	16	35	33	96	43	53
Falls from heights greater than 1 story.....	0	0	1	0	0	1	0	1
Vehicle-pedestrian collisions <sup>1</sup> .....	0	1	2	2	0	5	4	1
Other and unreported incidents.....	1	2	0	7	1	11	2	9

<sup>1</sup> Includes 4 pedestrians hit by cars and 1 hit by bicycle.

The recorded anatomical site of fracture was the femoral neck or trochanter in 88 percent of the Elmira women 60 years or older. There was a significant shift in the site of fracture with age ( $P < 0.01$ ). Of the femoral fractures sustained by women 60 through 74 years old, 52 percent were femoral neck fractures and 32 percent were trochanteric fractures. In the

women 75 years or older, 36 percent of the injuries were femoral neck fractures and 56 percent were trochanteric fractures (table 5). The right femur was fractured in 119 cases and the left in 132, a difference that is not significant ( $P > 0.3$ ).

The following monthly-incidence data (combined for 1948-57) on femoral fractures in El-

**Table 4. Recorded concomitant bone pathology for Elmira women 60 years or older, 1948-57**

Pathology	Age group (years)						Total 1948-52	Total 1953-57
	60-64	65-69	70-74	75-84	85 or over	Total		
Congenital dislocation.....	0	0	0	2	0	2	1	1
Degenerative bone changes.....	1	2	2	4	5	14	6	8
Healed fracture, different site.....	0	1	5	1	2	9	4	5
Healed fracture, same site.....	0	0	0	3	0	3	2	1
Hemorrhagic infarct.....	0	0	0	1	0	1	0	1
Nonspecific bone lesion.....	0	1	1	0	0	2	2	0
Osteoarthritis.....	0	0	0	4	1	5	0	5
Osteoporosis.....	0	2	2	2	1	7	3	4
Paget's disease.....	0	0	0	0	1	1	1	0
Possible malignancy.....	1	0	1	2	1	5	3	2
Total with concomitant bone pathology.....	2	6	11	19	11	49	22	27
Percent with concomitant bone pathology..	11	19	26	17	22	20	19	20

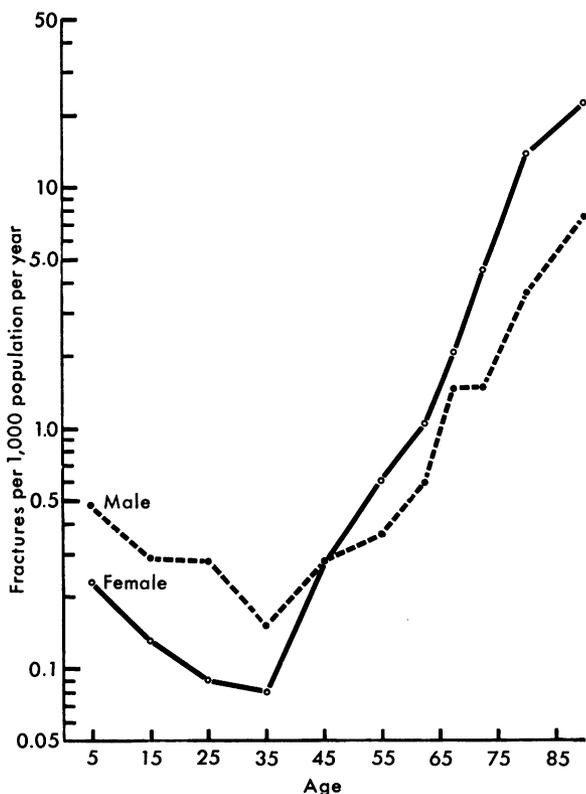
**Table 5. Femoral fractures in Elmira women 60 years and older, by anatomical site and age group, 1948-57**

Fractures	Age group (years)					
	60-64	65-69	70-74	75-84	85 or over	Total
Right leg.....	11	22	16	48	22	119
Head.....	1	0	0	0	0	1
Neck.....	7	8	11	22	5	53
Trochanter.....	3	10	3	22	16	54
Shaft.....	0	0	0	3	0	3
Condyle.....	0	2	1	0	0	3
Multiple sites.....	0	2	1	1	1	5
Unrecorded.....	0	0	0	0	0	0
Left leg.....	7	9	26	61	29	132
Head.....	0	0	1	0	0	1
Neck.....	3	5	13	21	9	51
Trochanter.....	4	2	7	35	16	64
Shaft.....	0	1	2	3	3	9
Condyle.....	0	1	0	1	0	2
Multiple sites.....	0	0	2	1	0	3
Unrecorded.....	0	0	1	0	1	2
Right and left leg.....	18	31	42	109	51	251
Head.....	1	0	1	0	0	2
Neck.....	10	13	24	43	14	104
Trochanter.....	7	12	10	57	32	118
Shaft.....	0	1	2	6	3	12
Condyle.....	0	3	1	1	0	5
Multiple sites.....	0	2	3	2	1	8
Unrecorded.....	0	0	1	0	1	2

mira women gives no evidence of apparent seasonal trend or increased incidence during winter months.

	<i>Number of fracture cases</i>
1948-57	
January -----	22
February -----	21
March -----	18
April -----	25
May -----	14
June -----	24
July -----	26
August -----	18
September -----	19
October -----	23
November -----	22
December -----	19
Total -----	251

**Figure 2. Femoral fracture rates in Chemung County including Elmira, by age and sex**



NOTE: Rates for women under 60 years of age and for men of all ages were calculated on the basis of data indicating that 85 percent of the femoral fracture patients admitted to the two hospitals in Elmira were county residents.

Age-specific femoral fracture rates for men and women in Chemung County including Elmira are compared in figure 2.

### Discussion and Conclusions

Sodium fluoride recently has been used therapeutically for several bone diseases, and the reported beneficial results have drawn attention to the role of fluoride in bone metabolism. Bernstein and associates (1) have reported increased bone mineralization and a tendency toward an increased bone accretion after fluoride therapy. Other reported results include positive changes in calcium balance and relief of bone pain (1-3). Leone and co-workers (4) have reported results that "... [support] the hypothesis that disadvantageous effects on the bone structure of the adult population may be associated with the prolonged use of drinking water that contains an insufficient concentration of fluoride."

With reference to these results, it has been conjectured that a fluoridated water supply might effectively raise the injury threshold of bone in a susceptible population and thereby lower fracture rates (5). Our results do not support this hypothesis for women of postmenopausal age at the time of fluoridation. The femoral fracture rates for women 60 years or older did not change significantly in the 5 years following fluoridation of the Elmira water supply.

The age of our study population when the Elmira water supply was fluoridated as well as the duration of fluoride ingestion must be considered in evaluating our results. Whether femoral fracture rates for older women would be affected if fluoridated water were ingested before the age period in which the rates begin to increase sharply (fig. 2) or ingested for longer periods should be investigated. In addition, the concentration of fluoride in bone is affected by the amount ingested (1-3, 6, 7); the beneficial therapeutic doses, 20-200 mg. sodium fluoride per day (1-3), have been considerably higher than the amount ingested from fluoridated water.

Our results are similar to those reported in a study of high school boys and young men that showed no relation of bone-fracture experience

to fluoride exposure (8). However, the femoral fracture rates for the young men were not similar to those for the older women, and factors contributing to exposure to mechanical forces of unusual magnitude and to risk of injury when these forces are experienced also would probably differ for the two groups.

Despite our results in relation to fluoride ingestion, our data suggest that a lowered injury threshold is involved in the etiology of femoral fractures in postmenopausal women since a large proportion of the fractures were attributed to minor falls that would not be expected to cause fractures in younger persons (table 3). Collateral evidence has been reported by Bauer (9) indicating that a change in the quality of the skeleton is a major factor in fractures of the femoral neck. The reported results of a study of forearm fractures also implicate progressive fragility of the skeleton as an important cause of fractures in middle-aged and aged women (10). In addition, the importance of progressive fragility is widely attested to by clinicians.

Our findings with respect to an association of age and fracture site are similar to those of Alffram (11). He observed that the average age of women with trochanteric fractures was significantly higher than that of women with cervical fractures. These results might indicate that the relative injury thresholds of the trochanter and femoral neck change with age or that a shift occurs in type of fall with age. In support of the concept of selective bone changes with age, the results of a study of femoral dimensions indicate that increases in periosteal diameter with age are not similar at all femoral sites (12).

Additional studies on changes in injury thresholds should include determination of age and sex-specific fracture rates per fall, by type of fracture and severity of fall, and in vitro tests of femoral resistance to mechanical forces in relation to age, sex, and bone pathology. In such in vitro studies the biases that may result from the use of bones from injured persons should be carefully considered (13).

The meaning of the data on lateral incidence is unknown. Oltman and Friedman (14) reported a higher incidence of left femoral fractures, but Christiansen (15) observed no left-

right difference. Our results suggest a shift from a right- to a left-sided predominance with increasing age, but the association is not significant ( $P>0.10$ ). Alffram (11) reported that fracture of the proximal end of the femur was more common on the left than on the right side but noted that the difference was more pronounced (a) under the age of 60, (b) in men than in women, and (c) after severe rather than moderate trauma.

The mean annual fracture rate for women 60 years or older was lower for residents of the county excluding Elmira than for those living in Elmira. This difference was not a result of admissions of Chemung County fracture patients to other hospitals. Hospital records in the surrounding counties were studied, and no Chemung County residents were found among the 1948-57 admissions of women 60 years or older with femoral fractures.

Chemung County excluding Elmira is relatively rural. The difference in fracture rates might reflect urban-rural differences in exposure to risk, kinds of hazards, population susceptibility to falls, or population susceptibility to injury when falls occur.

The reported concomitant bone pathology probably does not indicate true prevalence. The clinical diagnosis of osteoporosis is somewhat arbitrary, and the observation and recording of pre-existing bone pathology would have varied with time and physician. Additional epidemiologic study should be directed toward accurate measurement of the incidence and prevalence of bone pathology in both a pertinent clinical series and the corresponding general population. Alffram (11) has reported a study in Sweden in which only 19 of 1,664 cases of femoral fractures occurring among persons of both sexes and all ages were associated with radiographically apparent, localized skeletal lesions such as primary and secondary tumors and cystic processes.

No seasonal or cyclical variation occurred in the monthly incidence of fractures. An increase might be expected in the winter, when driving and walking conditions are more dangerous, and for this reason Sheldon (16) has suggested that in the United Kingdom a reported geographic difference in death rates from falls in old age might be related to the frequency of

falls on ice and snow. This finding of a lack of seasonal variation in femoral fracture rates is consistent with similar evidence from Monroe County, another upstate New York area. There, although most skeletal X-ray examinations of women are performed more frequently in winter than in other seasons, the same is not true of examinations of the thigh and knee combined (17).

In Chemung County including Elmira, age-specific femoral fracture rates for men exceeded those for women during the first 40 years of life, after which the rates for women were consistently and progressively greater (fig. 2). A similar age and sex distribution of fractures of the upper femur has been reported in a study of fracture patterns in England and Wales (18).

It is quite likely that the difference between the rates for men and women younger than 40 years of age reflects primarily a greater exposure of men to risk in recreational, occupational, and traffic situations. However, the increased rates with age for both men and women 40 years or older probably results in part from a progressive lowering of mechanical injury thresholds in at least some of the middle-aged and older population. The relatively greater increase with age in rates for women might reflect corresponding shifts in environmental hazards, tendency to fall, susceptibility to injury, or a combination of such factors.

The magnitude of the research job ahead is indicated by the fact that the relative contributions of such factors to femoral and other fractures are at present almost completely unknown in quantitative terms (19). As a result, many injury-prevention programs lack the data necessary for rational planning.

### Summary

Femoral fracture incidence among women 60 years or older in Chemung County including Elmira, N.Y., was studied before and after fluoridation of their community water supply. The femoral fracture rates during the 5 years after fluoridation did not change significantly. Whether fracture rates are lowered when women receive fluoridated water before the menopause or for longer periods is unknown and should be investigated.

A large proportion of the femoral fractures in women 60 years or older were attributed to minor falls. These data support previous evidence that a decreased mechanical injury threshold is involved in the etiology of femoral fractures in older women.

The femoral neck and trochanter were the most common anatomical sites of fracture, and a shift in the site of fracture with age was found. There was no evidence of increased fracture incidence in winter months.

Age-specific femoral fracture rates for men exceeded those for women during the first 40 years of life, after which the rates for women were progressively higher than the rates for men, although increases in the rates for men also were observed.

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### New Drug for Psychoses

A new drug for treating persons suffering from psychosis shows effective results from one injection for periods up to 22 days.

The prolonged effects of fluphenazine decanoate, a new form of a major tranquilizing drug, phenothiazine, stem from its ability to act as a depot from which phenothiazine is released slowly.

The slow release qualities of the drug were discovered at the Rockland Hospital in Orangeburg, N.Y., under a Public Health Service research grant from the National Institute of Mental Health.

After a single injection of 12½ mg. of fluphenazine decanoate, 9 out of 12 chronic schizophrenic patients who had become drug resistant after 3 to 34 years of hospitalization improved rapidly. The effects continued from 16 to 22 days. A double dose brought response lasting 21 to 27 days in some cases.

The long-lasting qualities of fluphenazine decanoate make it particularly advantageous compared to those tranquilizing drugs which must be administered two to four times a day.

It is felt that since fluphenazine decanoate is rapid acting and gives assured blood levels of medication with, at the most, bimonthly doses, it has both economic and practical value in treating hospitalized and ambulatory psychiatric patients.